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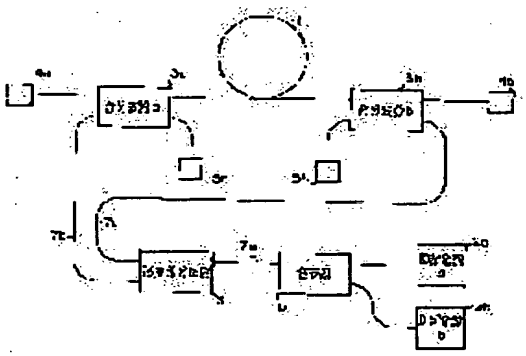
(54) OPTICAL FIBER AMPLIFIER

(57)Abstract:
PURPOSE: To obtain a low-noise or high-output rare earth element doped optical fiber amplifier according to the purpose of use without extremely increasing or decreasing the load on an exciting light source.
CONSTITUTION: Exciting light beams emitted by an exciting light source 2a and an exciting light source 2b are multiplexed by a multiplexer 10 and then made incident on a variable optical branching unit 6, which branches the multiplexed light into two at an optional ratio. The exciting light outputted from a branch output terminal a7b is made incident on a rare earth element doped optical fiber 1 through a multiplexer demultiplexer a3a and the exciting light outputted from a branch output terminal b7c is made incident through a multiplexer demultiplexer b3b. The signal light is amplified in the rare earth element doped optical fiber 1 and passed through the multiplexer demultiplexer b3b and then projected from a signal light output terminal 4b. The ratio of the branch output of the exciting light to the branch output terminal a7b of the variable optical branching unit 6 and the branch output to the branch' output terminal b7c is varied to obtain the low-noise or high-output rare earth element doped optical fiber amplifier.



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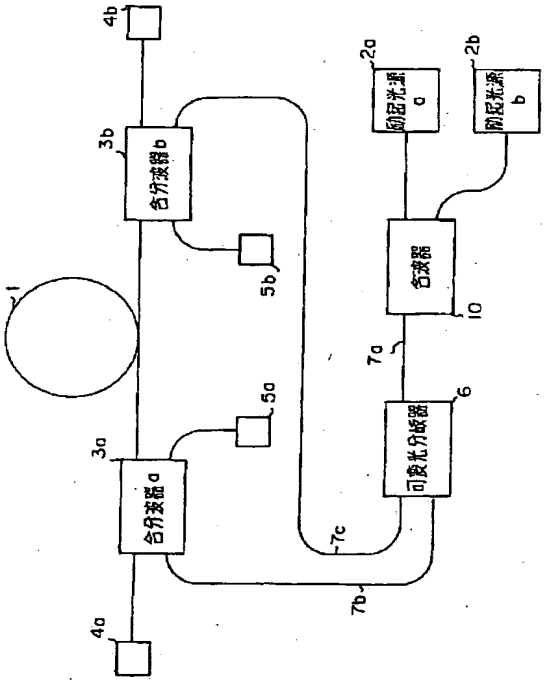
(54)【発明の名称】　光ファイバ増幅器

(57)【要約】
【目的】　励起光源の負荷が極端に高低することなく、用途に応じて低雑音なもしくは高出力な希土類元素ドープ光ファイバ増幅器を得ることを目的とする。
【構成】　励起光源２ａ及び励起光源２ｂより出射された励起光は、合波器１０で合波された後、可変光分岐器６に入射され任意の比率に２分岐される。分岐出力端ａ７ｂより出力された励起光は合分波器ａ３ａを通じて、分岐出力端ｂ７ｃより出力された励起光は合分波器ｂ３ｂを通じて、希土類元素ドープ光ファイバ１に入射される。信号光は希土類元素ドープ光ファイバ１中で増幅され、合分波器ｂ３ｂを通過した後信号光出力端子４ｂより出射される。励起光の可変光分岐器６の分岐出力端ａ７ｂへの分岐出力と、分岐出力端ｂ７ｃへの分岐出力比率を変えることにより、低雑音なあるいは高出力な希土類元素ドープ光ファイバ増幅器が得られる。



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【特許請求の範囲】
【請求項１】　以下の要素を有する光ファイバ増幅器
（ａ）信号光を入力して出力する光ファイバ、（ｂ）励起光を出力する励起光源、（ｃ）上記励起光源からの励起光を任意の比率に分岐する可変光分岐器、（ｄ）上記光ファイバの信号光の入力側と出力側にそれぞれ配置され、上記可変光分岐器により分岐された励起光と光ファイバの信号光を合波する合波手段。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】この発明は、たとえば、希土類元素ドープ光ファイバに信号光及び励起光を入射して信号光を増幅する希土類元素ドープ光ファイバ増幅器に関するものである。
【０００２】
【従来の技術】図４は文献電子情報通信学会技術研究報告Ｖｏｌ．９０，Ｎｏ．２０６，ＯＱＥ９０－８０，ｐｐ５９－６４に記載された希土類元素ドープ光ファイバ増幅器の構成図である。図において１は希土類元素ドープ光ファイバ、２ａは励起光源ａ、２ｂは励起光源ｂ、３ａは合分波器ａ、３ｂは合分波器ｂ、４ａは信号光入力端子、４ｂは信号光出力端子、５ａは合分波器ａ３ａの無反射終端ａ、５ｂは合分波器ｂ３ｂの無反射終端ｂである。
【０００３】次に動作について説明する。信号光入力端子４ａより入射された信号光は、合分波器ａ３ａを通過した後、希土類元素ドープ光ファイバ１に入射される。励起光源ａ２ａより出射された励起光は、合分波器ａ３ａを通過した後、希土類元素ドープ光ファイバ１に入射される。励起光源ｂ２ｂより出射された励起光は、合分波器ｂ３ｂを通過した後、希土類元素ドープ光ファイバ１に入射される。希土類元素ドープ光ファイバ１中の希土類元素に励起光が照射されることにより信号光が増幅される。増幅された信号光は希土類元素ドープ光ファイバ１より出射され合分波器ａ３ａを通過した後、信号光出力端子４ｂより出射される。
【０００４】励起光源ａ２ａを動作させ励起光源ｂ２ｂを非動作させた場合、励起光は希土類元素ドープ光ファイバ１の信号光入力側からのみ希土類元素ドープ光ファイバ１に入射される。この励起方法は前方励起と称されている。上記文献の記載によれば、前方励起にすることにより、低雑音な希土類元素ドープ光ファイバ増幅器が得られる。反面最大光出力は小さい。このため前方励起は、多段増幅器の初段増幅器などのように低雑音であることが要求される用途に適している。
【０００５】上記とは反対に、励起光源ａ２ａを非動作させ励起光源ｂ２ｂを動作させた場合、励起光は希土類元素ドープ光ファイバ１の信号光出力側からのみ希土類元素ドープ光ファイバ１に入射される。この励起方法は後方励起と称されている。上記文献の記載によれば、後

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方励起にすることにより、高出力な希土類元素ドープ光ファイバ増幅器が得られる。反面雑音は高い。このため後方励起は、多段増幅器の終段増幅器などの高出力であることが要求される用途に適している。
【０００６】励起光源ａ２ａと励起光源ｂ２ｂの両方を動作させた場合、励起光は希土類元素ドープ光ファイバ１の信号光入力側と信号光出力側の両方から希土類元素ドープ光ファイバ１に入射される。この励起方法は両方向励起と称されている。両方向励起の希土類元素ドープ光ファイバ増幅器は、前方励起の希土類元素ドープ光ファイバ増幅器と後方励起の希土類元素ドープ光ファイバ増幅器の間の特性を示す。両方向励起の希土類元素ドープ光ファイバ増幅器では、希土類元素ドープ光ファイバ信号光入力側の励起光入力と希土類元素ドープ光ファイバの信号光出力側の励起光入力の比率を、用途に応じて調整することにより、適当な雑音特性と信号光出力が得られる。両方向励起において、希土類元素ドープ光ファイバ１の信号光入力側より入射される励起光が、希土類元素ドープ光ファイバ１の信号光出力側より入射される励起光よりも大きいほど、前方励起の希土類元素ドープ光ファイバ増幅器の特性に近くなり、より低雑音な希土類元素ドープ光ファイバ増幅器が得られる。反対に、両方向励起において、希土類元素ドープ光ファイバ１の信号光出力側より入射される励起光が、希土類元素ドープ光ファイバ１の信号光入力側より入射される励起光よりも大きいほど、後方励起の希土類元素ドープ光ファイバ増幅器の特性に近くなり、より高出力な希土類元素ドープ光ファイバ増幅器が得られる。
【０００７】
【発明が解決しようとする課題】従来の希土類元素ドープ光ファイバ増幅器は以上のように構成されているので、低雑音であることが要求される用途に対しては、希土類元素ドープ光ファイバの信号光入射側の励起光入力を大きくする必要があるため、希土類元素ドープ光ファイバの信号光入射側の励起光源は高負荷になりやすく、希土類元素ドープ光ファイバの信号光出力側の励起光源は低負荷になりやすい。反対に、高出力であることが要求される用途に対しては、希土類元素ドープ光ファイバの信号光出力側の励起光入力を大きくする必要があるため、希土類元素ドープ光ファイバの信号光入射側の励起光源は低負荷になりやすく、希土類元素ドープ光ファイバの信号光出力側の励起光源は高負荷になりやすい。励起光源の高負荷状態は信頼性が低下するという問題点があった。また、低負荷状態の励起光源は増幅作用に寄与する割合が低く、取付けコストが無駄になるという問題点があった。
【０００８】上記の負荷が極端に低くなる励起光源は実使用上では不要であるため、低雑音であることが要求される用途に対しては前方励起用の励起光源のみを取り付けた構成の希土類元素ドープ光ファイバ増幅器を使用

し、高出力であることが要求される用途に対しては後方励起用の励起光源のみを取り付けた構成の希土類元素ドープ光ファイバ増幅器を使用することが考えられる。しかし、用途が変更された場合は希土類元素ドープ光ファイバ増幅器全体を交換する必要があり、両方向励起の希土類元素ドープ光ファイバ増幅器の持っている用途に応じて適当な雑音特性と信号光出力が得られるという特長が失われ、汎用性に欠けるという問題点があった。

【０００９】この発明は上記のような問題点を解決するためになされたもので、励起光源の負荷が極端に高くなるあるいは低くなることなく、光ファイバの信号光入力側から入射する励起光と光ファイバの信号光出力側から入射する励起光の割合を容易に変えることができ、用途に応じて低雑音な光ファイバ増幅器もしくは高出力な光ファイバ増幅器を得ることを目的とする。

【００１０】

【課題を解決するための手段】この発明に係る光ファイバ増幅器は、励起光源より出射された励起光を任意の比率に分岐する可変光分岐器を備え、分岐された一方の励起光が光ファイバの信号光入力側の合分波器を通過した後に光ファイバに入射され、上記分岐された他方の励起光が光ファイバの信号光出力側の合分波器を通過した後に光ファイバに入射されるようにしたものである。

【００１１】

【作用】この発明に係る光ファイバ増幅器においては、可変光分岐器が、励起光を任意の比率に分岐し、励起光を分岐する比率を光ファイバの信号光入射側への分岐比率を高くし、光ファイバの信号光出力側への分岐比率を低くすることにより、前方励起の光ファイバ増幅器の特性に近くなり、低雑音な光ファイバ増幅器が得られる。反対に、励起光を分岐する比率を光ファイバの信号光入射側への分岐比率を低くし、光ファイバの信号光出力側への分岐比率を高くすることにより、後方励起の光ファイバ増幅器の特性に近くなり、より高出力な光ファイバ増幅器が得られる。また、励起光源は一定の負荷で駆動され負荷が極端に高くなるあるいは低くなることはなく、用途に応じて可変光分岐器の分岐比率を変えることにより、任意に低雑音な光ファイバ増幅器もしくは高出力な光ファイバ増幅器を得ることができる。

【００１２】

【実施例】

実施例１．以下、この発明の一実施例を図について説明する。図１はこの発明の一実施例の構成図である。図において１は希土類元素ドープ光ファイバ、２ａは励起光源ａ、３ａは合分波器ａ、３ｂは合分波器ｂ、４ａは信号光入力端子、４ｂは信号光出力端子、５ａは合分波器ａ３ａの無反射終端ａ、５ｂは合分波器ｂ３ｂの無反射終端ｂ、６は可変光分岐器、７ａは可変光分岐器６の入力端、７ｂは可変光分岐器６の分岐出力端ａ、７ｃは可変光分岐器６の分岐出力端ｂである。

【００１３】次に動作について説明する。励起光源２ａより出射された励起光は、可変光分岐器入力端７ａより可変光分岐器６に入射され、任意の比率に２分岐され、分岐出力端ａ７ｂと分岐出力端ｂ７ｃより出力される。分岐出力端ａ７ｂより出力された励起光は、希土類元素ドープ光ファイバ１の信号光入射側の合分波器ａ３ａにより、信号光入力端子４ａより入射した信号光と合波され、希土類元素ドープ光ファイバに入射される。分岐出力端ｂ７ｃより出力された励起光は、希土類元素ドープ光ファイバ１の信号光出射側の合分波器ｂ３ｂを通過した後、希土類元素ドープ光ファイバ１に入射される。希土類元素ドープ光ファイバ１に入射された信号光は、希土類元素ドープ光ファイバ１中の希土類元素の作用により増幅され、希土類元素ドープ光ファイバ１より出射され合分波器ｂ３ｂを通過した後、信号光出力端子４ｂより出射される。

【００１４】図２は可変光分岐器６の一構成例を示す図である。図において７ａは可変光分岐器６の入力端、７ｂは可変光分岐器６の分岐出力端ａ、７ｃは可変光分岐器６の分岐出力端ｂ、８は反射率／透過率可変円板、９は全反射ミラーである。入力端７ａより入射された励起光は反射率／透過率可変円板８により２分岐され、分岐された一方は出力端ａ７ｂより出力され、別の分岐された一方は全反射ミラー９で折り返された後、分岐出力端ｂ７ｃより出力される。反射率／透過率可変円板８の表面には、円周方向に反射率／透過率が連続的に変化する薄膜が施されており、反射率／透過率可変円板８を回転させることにより反射率／透過率が変化し、分岐出力端ａ７ｂと分岐出力端ｂ７ｃに任意の比率で励起光が出力される。

【００１５】励起光の可変光分岐器６の分岐出力端ａ７ｂへの分岐比率を高くし、可変光分岐器６の分岐出力端ｂ７ｃへの分岐比率を低くすることにより、前方励起の希土類元素ドープ光ファイバ増幅器の特性に近くなり、低雑音な希土類元素ドープ光ファイバ増幅器が得られる。反対に、励起光の可変光分岐器６の分岐出力端ａ７ｂへの分岐比率を低くし、可変光分岐器６の分岐出力端ｂ７ｃへの分岐比率を高くすることにより、後方励起の希土類元素ドープ光ファイバ増幅器の特性に近くなり、より高出力な希土類元素ドープ光ファイバ増幅器が得られる。

【００１６】分岐比率の変更は、反射率／透過率可変円板８を回転させることで行えるため極めて容易である。このため、用途に応じて適当な雑音特性と信号光出力特性を持つ希土類元素ドープ光ファイバ増幅器の実現が容易で、汎用性の高い希土類元素ドープ光ファイバ増幅器が実現できる。また、励起光源は一定負荷の状態で駆動されているため、高負荷や低負荷にはならない。

【００１７】以上のように、この実施例では、励起光の照射により信号光を増幅する希土類元素を光ファイバに

ドープした希土類元素ドープ光ファイバと、励起光を出力する励起光源と、上記希土類元素ドープ光ファイバの一端と光学的に結合された励起光と信号光の合分波器ａと、上記希土類元素ドープ光ファイバの一端と異なる端と光学的に結合された励起光と信号光の合分波器ｂを備えた希土類元素ドープ光ファイバ増幅器において、上記励起光源より出射された励起光を任意の比率に２分岐する可変光分岐器を備え上記可変光分岐器の分岐の一方が上記合分波器ａと光学的に結合され、上記可変光分岐器の分岐の他方が上記合分波器ｂと光学的に結合されたことを特徴とする希土類元素ドープ光ファイバ増幅器を説明した。

【００１８】実施例２．以下、この発明の別の一実施例を図について説明する。図３はこの発明の別の一実施例の構成図である。図において１は希土類元素ドープ光ファイバ、２ａは励起光源ａ、２ｂは励起光源ｂ、３ａは合分波器ａ、３ｂは合分波器ｂ、４ａは信号光入力端子、４ｂは信号光出力端子、５ａは合分波器ａ３ａの無反射終端ａ、５ｂは合分波器ｂ３ｂの無反射終端ｂ、６は可変光分岐器、７ａは可変光分岐器６の入力端、７ｂは可変光分岐器６の分岐出力端ａ、７ｃは可変光分岐器６の分岐出力端ｂ、１０は合波器である。

【００１９】次に動作について説明する。励起光源２ａより出射された励起光及び励起光源２ｂより出射された励起光は、合波器１０で合波された後、可変光分岐器入力端７ａより可変光分岐器６に入射される。以後の動作は、上記実施例１の動作と同様である。また、上記実施例１と同様に、用途に応じて適当な雑音特性と信号光出力特性を持つ希土類元素ドープ光ファイバ増幅器の実現が容易で、励起光源２ａ及び励起光源２ｂはいづれも一定負荷の状態で駆動されているため高負荷や低負荷にはならず、汎用性の高い希土類元素ドープ光ファイバ増幅器が実現できる。

【００２０】実施例３．上記実施例において、可変光分岐器６は、反射率／透過率可変円板８を回転させることにより、励起光を任意の比率に分岐する場合を示したが、回転により比率を決定する場合に限らず、角度の変更により反射率／透過率を変更させるような場合でもかまわない。あるいは、前述のようにメカニカルな変更に限らず、部品の材質を変更したり、制御回路により、電界・磁界を変更したりすることにより反射率／透過率を変化させるような場合でもかまわない。

【００２１】実施例４．上記実施例においては、合分波器３ａ、３ｂを用いて励起光と信号光とを合波させる場合を示したが、光カップラや合波器等の合分波器以外の合波手段を用いてもかまわない。

【００２２】実施例５．上記実施例においては、希土類元素をドープした光ファイバの場合を例にして説明したが、その他の光ファイバでも励起光により増幅される性質がある光ファイバであれば、この発明が適用できる。

【００２３】

【発明の効果】以上のように、この発明に係る光ファイバ増幅器によれば、用途に応じて構成を変更する必要なく容易に低雑音な光ファイバ増幅器あるいは高出力な光ファイバ増幅器が実現でき、励起光源は高負荷や低負荷にはならず、信頼性が確保できると共に効率良く増幅作用に寄与できるという効果がある。

【図面の簡単な説明】

【図１】この発明の一実施例による希土類元素ドープ光ファイバ増幅器の構成図である。

【図２】この発明の一実施例に用いる可変光分岐器の一構成例を示す図である。

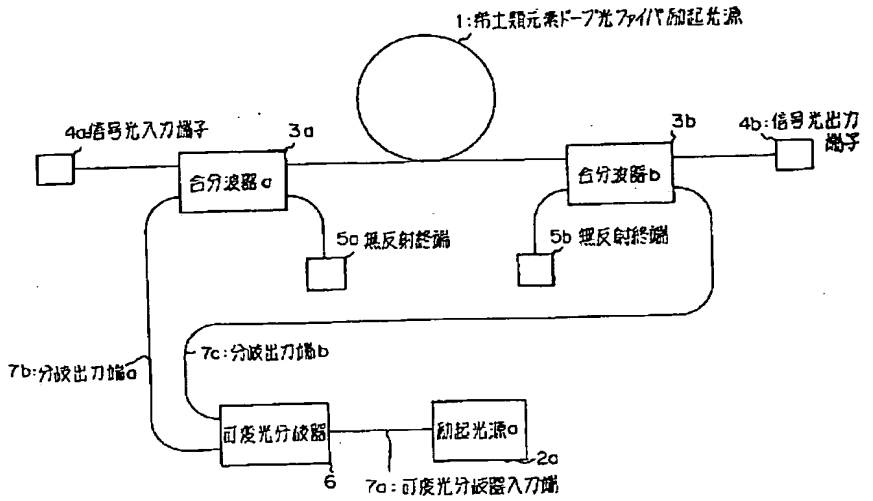
【図３】この発明の別の一実施例による希土類元素ドープ光ファイバ増幅器の構成図である。

【図４】従来の希土類元素ドープ光ファイバ増幅器の構成図である。

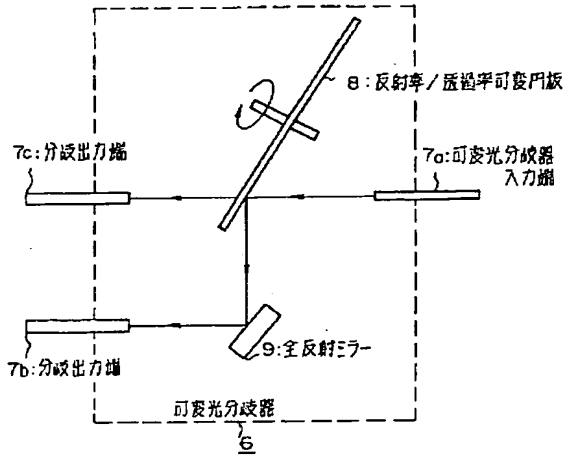
【符号の説明】

１　希土類元素ドープ光ファイバ励起光源
２ａ　励起光源ａ
２ｂ　励起光源ｂ
３ａ　合分波器ａ
３ｂ　合分波器ｂ
４ａ　信号光入力端子
４ｂ　信号光出力端子
５ａ　合分波器ａの無反射終端ａ
５ｂ　合分波器ｂの無反射終端ｂ
６　可変光分岐器
７ａ　可変光分岐器入力端
７ｂ　可変光分岐器の分岐出力端ａ
７ｃ　可変光分岐器の分岐出力端ｂ
８　反射率／透過率可変円板
９　全反射ミラー
１０　合波器

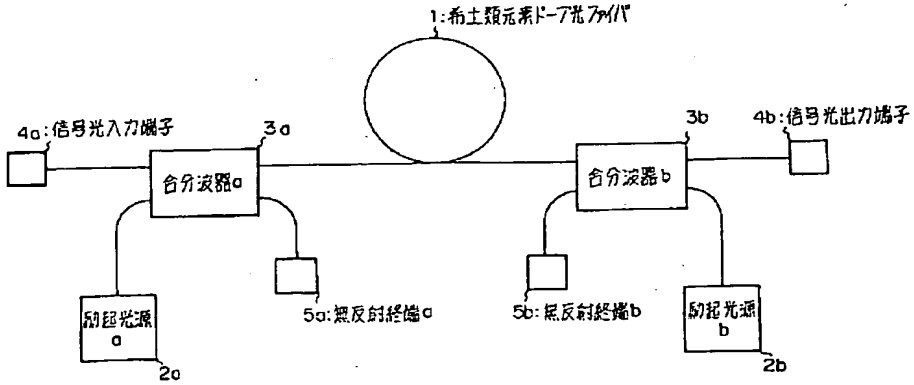
【図１】


1:希土類元素ドープ光ファイバ励起光源
4a信号光入力端子
3a
3b
4b:信号光出力端子
合分波器a
合分波器b
5a無反射終端
5b無反射終端
7c:分岐出力端b
7b:分岐出力端a
可変光分岐器
励起光源a
2a
6
7a:可変光分岐器入力端

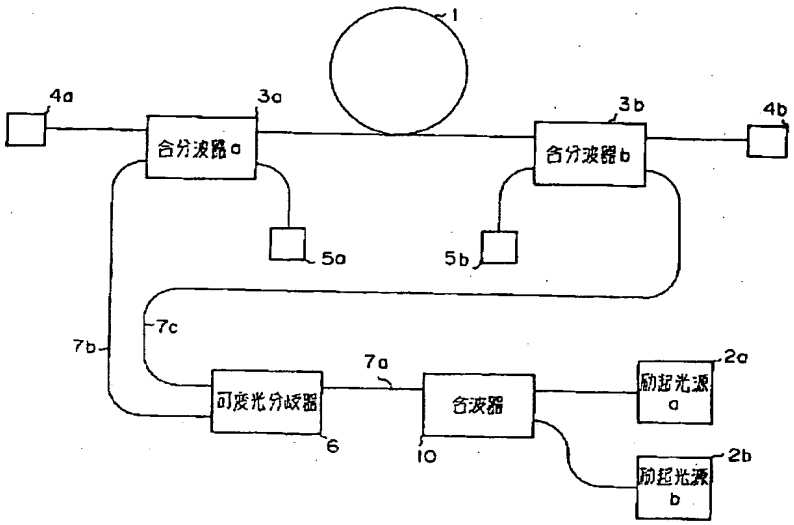
【図２】


8:反射率/透過率可変円板
7c:分岐出力端
7a:可変光分岐器入力端
9:全反射ミラー
7b:分岐出力端
可変光分岐器
6

【図４】


1:希土類元素ドープ光ファイバ
4a:信号光入力端子
3a
3b
4b:信号光出力端子
合分波器a
合分波器b
励起光源a
2a
5a:無反射終端a
5b:無反射終端b
励起光源b
2b

【図３】


1
4a
3a
合分波器a
3b
合分波器b
4b
5a
5b
7c
7b
7a
可変光分岐器
6
合波器
10
励起光源a
2a
励起光源b
2b

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(22)Date of filing :
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(54) OPTICAL FIBER AMPLIFIER

(57)Abstract:
PURPOSE: To obtain a low-noise or high-output rare earth element doped optical fiber amplifier according to the purpose of use without extremely increasing or decreasing the load on an exciting light source.
CONSTITUTION: Exciting light beams emitted by an exciting light source 2a and an exciting light source 2b are multiplexed by a multiplexer 10 and then made incident on a variable optical branching unit 6, which branches the multiplexed light into two at an optional ratio. The exciting light outputted from a branch output terminal a7b is made incident on a rare earth element doped optical fiber 1 through a multiplexer demultiplexer a3a and the exciting light outputted from a branch output terminal b7c is made incident through a multiplexer demultiplexer b3b. The signal light is amplified in the rare earth element doped optical fiber 1 and passed through the multiplexer demultiplexer b3b and then projected from a signal light output terminal 4b. The ratio of the branch output of the exciting light to the branch output terminal a7b of the variable optical branching unit 6 and the branch output to the branch' output terminal b7c is varied to obtain the low-noise or high-output rare earth element doped optical fiber amplifier.

LEGAL STATUS
[Date of request for examination]

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[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] A multiplexing means multiplex the excitation light and the signal light of an optical fiber which have been arranged at the input side and the output side of signal light of a good light variation turnout and the (d) above-mentioned optical fiber which branches the excitation light from the optical fiber which inputs and outputs the optical fiber (amplifier a) signal light which has the following elements, the excitation light source which outputs (b) excitation light, and the (c) above-mentioned excitation light source into the ratio of arbitration, respectively, and branched by the above-mentioned good light variation turnout.

[Translation done.]
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the rare-earth-elements dope optical fiber amplifier which carries out incidence of signal light and the excitation light to for example, a rare-earth-elements dope optical fiber, and amplifies signal light.
[0002]
[Description of the Prior Art] Drawing 4 is the block diagram of the rare-earth-elements dope optical fiber amplifier indicated by reference Institute of Electronics, Information and Communication Engineers technical research report Vol.90, No.206, OQE 90-80, and pp 59-64. drawing -- setting -- 1 -- a rare-earth-elements dope optical fiber and 2a -- the excitation light source a and 2b -- for Multi/demulitiplexer b and 4a, a signal light input terminal and 4b are [the excitation light source b and 3a / Multi/demulitiplexer a and 3b / the nonreflective termination a of multi/demulitiplexer a3a and 5b of a signal optical output terminal and 5a] the nonreflective termination b of multi/demulitiplexer b3b.
[0003] Next, actuation is explained. After the signal light by which incidence was carried out from signal light input terminal 4a passes multi/demulitiplexer a3a, incidence of it is carried out to the rare-earth-elements dope optical fiber 1. After the excitation light by which outgoing radiation was carried out from excitation light source a2a passes multi/demulitiplexer a3a, incidence of it is carried out to the rare-earth-elements dope optical fiber 1. After the excitation light by which outgoing radiation was carried out from excitation light source b2b passes multi/demulitiplexer b3b, incidence of it is carried out to the rare-earth-elements dope optical fiber 1. Signal light is amplified when excitation light is irradiated by the rare earth elements in the rare-earth-elements dope optical fiber 1. After outgoing radiation of the amplified signal light is carried out and it passes multi/demulitiplexer a3a from the rare-earth-elements dope optical fiber 1, outgoing radiation of it is carried out from signal optical output terminal 4b.
[0004] When operating excitation light source a2a and un-operating excitation light source b2b, incidence of the excitation light is carried out to the rare-earth-elements dope optical fiber 1 only from the signal light input side of the rare-earth-elements dope optical fiber 1. This excitation approach is called front excitation. making it front excitation according to the publication of the above-mentioned reference -- low -- noise rare-earth-elements dope optical fiber amplifier is obtained. The opposite side maximum optical output is small. for this reason, front excitation -- the first rank of the multistage amplifier -- it is suitable for the application demanded that it is a low noise like amplifier.

[0005] When un-operating excitation light source a2a and operating excitation light source b2b contrary to the above, incidence of the excitation light is carried out to the rare-earth-elements dope optical fiber 1 only from the signal optical output side of the rare-earth-elements dope optical fiber 1. This excitation approach is called back excitation. According to the publication of the above-mentioned reference, high power rare-earth-elements dope optical fiber amplifier is obtained by making it back excitation. A opposite side noise is high. For this reason, it is suitable for the application demanded that back excitation is high power, such as a final amplifier of the multistage amplifier.

[0006] When operating both excitation light source a2a and excitation light source b2b, incidence of the excitation light is carried out to the rare-earth-elements dope optical fiber 1 from both the signal light input side of the rare-earth-elements dope optical fiber 1, and by the side of a signal optical output. This excitation approach is called both-directions excitation. The rare-earth-elements dope optical fiber amplifier of both-directions excitation shows the property between the rare-earth-elements dope optical fiber amplifier of front excitation, and the rare-earth-elements dope optical fiber amplifier of back excitation. In the rare-earth-elements dope optical fiber amplifier of both-directions excitation, a suitable noise property and a signal optical output are obtained by adjusting the ratio of the excitation light input by the side of the excitation light input of a rare-earth-elements dope optical fiber signal light input side, and the signal optical output of a rare-earth-elements dope optical fiber according to an application. so that the excitation light by which incidence is carried out from the signal light input side of the rare-earth-elements dope optical fiber 1 is larger than the excitation light by which incidence is carried out from the signal optical output side of the rare-earth-elements dope optical fiber 1 in both-directions excitation -- the property of the rare-earth-elements dope optical fiber amplifier of front excitation -- near -- becoming -- more -- low -- a noise rare-earth-elements dope optical fiber amplifier is obtained. It becomes close to the property of the rare-earth-elements dope optical fiber amplifier of back excitation, and a high power rare-earth-elements dope optical fiber amplifier is obtained, so that the excitation light by which incidence is carried out from the signal optical output side of the rare-earth-elements dope optical fiber 1 is larger than the excitation light by which incidence is carried out from the signal light input side of the rare-earth-elements dope optical fiber 1 in both-directions excitation on the contrary.

[0007]

[Problem(s) to be Solved by the Invention] Since the conventional rare-earth-elements dope optical fiber amplifier is constituted as mentioned above and that it is a low noise needs to enlarge the excitation light input by the side of the signal light incidence of a rare-earth-elements dope optical fiber to the application demanded, the excitation light source by the side of the signal light incidence of a rare-earth-elements dope optical fiber tends to become a heavy load, and the excitation light source by the side of the signal optical output of a rare-earth-elements dope optical fiber tends to become low loading. Since that it is high power needs to enlarge the excitation light input by the side of the signal

optical output of a rare-earth-elements dope optical fiber to the application demanded on the contrary, the excitation light source by the side of the signal light incidence of a rare-earth-elements dope optical fiber tends to become low loading, and the excitation light source by the side of the signal optical output of a rare-earth-elements dope optical fiber tends to become a heavy load. The heavy load condition of the excitation light source had the trouble that dependability fell. Moreover, the excitation light source of a low loading condition had the trouble that the rate which contributes to a magnification operation was low, and anchoring cost became useless.

[0008] It is possible that that it is a low noise uses the rare-earth-elements dope optical fiber amplifier of a configuration of having attached only the excitation light source for front excitation to the application demanded, and that it is high power uses the rare-earth-elements dope optical fiber amplifier of a configuration of having attached only the excitation light source for back excitation to the application demanded since the excitation light source to which the above-mentioned load becomes extremely low is unnecessary on real use. However, when an application was changed, the whole rare-earth-elements dope optical fiber amplifier needed to be exchanged, the features that a suitable noise property and a signal optical output are obtained according to the application which the rare-earth-elements dope optical fiber amplifier of both-directions excitation has were lost, and there was a trouble that versatility was missing.

[0009] it was made in order that this invention might solve the above troubles, and the load of the excitation light source becomes extremely high -- it is -- it is -- the rate of the excitation light which carries out incidence to the excitation light which carries out incidence from the signal light input side of an optical fiber from the signal optical output side of an optical fiber, without becoming low -- easy -- being changeable -- an application -- responding -- low -- it aims at obtaining a noise optical fiber amplifier or a high power optical fiber amplifier.

[0010]

[Means for Solving the Problem] After incidence is carried out to an optical fiber after it has the good light variation turnout which branches the excitation light by which outgoing radiation was carried out from the excitation light source into the ratio of arbitration, and while branched and excitation light passes the multi/demulitiplexer of the signal light input side of an optical fiber, and the excitation light of another side by which branching was carried out [above-mentioned] passes the multi/demulitiplexer by the side of the signal optical output of an optical fiber, the incidence of the optical fiber amplifier concerning this invention is made to be carried out to an optical fiber.

[0011]

[Function] making high the branching ratio by the side of the signal light incidence of an optical fiber for the ratio into which a good light variation turnout branches excitation light into the ratio of arbitration, and branches excitation light in the optical fiber amplifier concerning this invention, and making low the branching ratio by the side of the signal optical output of an optical fiber -- the property of the optical fiber amplifier of front excitation -- near -- becoming -- low -- noise optical

fiber amplifier is obtained. By making low the branching ratio by the side of the signal light incidence of an optical fiber on the contrary for the ratio which branches excitation light, and making high the branching ratio by the side of the signal optical output of an optical fiber, it becomes close to the property of the optical fiber amplifier of back excitation, and a high power optical fiber amplifier is obtained. moreover, the excitation light source is driven by the fixed load, and a load becomes extremely high -- it is -- it is -- not becoming low and changing the rate of a branching ratio of a good light variation turnout according to an application -- arbitration -- low -- a noise optical fiber amplifier or a high power optical fiber amplifier can be obtained.

[0012]

[Example]

One example of this invention is explained about drawing below example 1. Drawing 1 is the block diagram of one example of this invention. In drawing 1 the excitation light source a and 3a for a rare-earth-elements dope optical fiber and 2a Multi/demulitiplexer a 3b a signal light input terminal and 4b for Multi/demulitiplexer b and 4a A signal optical output terminal, For the nonreflective termination b of multi/demulitiplexer b3b, and 6, a good light variation turnout and 7a are [5a / the nonreflective termination a of multi/demulitiplexer a3a, and 5b / the branching outgoing end a of the good light variation turnout 6 and 7c of the input edge of the good light variation turnout 6 and 7b] the branching outgoing ends b of the good light variation turnout 6.

[0013] Next, actuation is explained. Incidence of the excitation light by which outgoing radiation was carried out from excitation light source 2a is carried out to the good light variation turnout 6 from good light variation turnout input edge 7a, it dichotomizes into the ratio of arbitration, and is outputted from branching outgoing end a7b and branching outgoing end b7c. From signal light input terminal 4a, it is multiplexed with the signal light which carried out incidence by multi/demulitiplexer a3a by the side of the signal light incidence of the rare-earth-elements dope optical fiber 1, and incidence of the excitation light outputted from branching outgoing end a7b is carried out to a rare-earth-elements dope optical fiber. After the excitation light outputted from branching outgoing end b7c passes multi/demulitiplexer b3b by the side of the signal light outgoing radiation of the rare-earth-elements dope optical fiber 1, incidence of it is carried out to the rare-earth-elements dope optical fiber 1. The signal light by which incidence was carried out to the rare-earth-elements dope optical fiber 1 is amplified by operation of the rare earth elements in the rare-earth-elements dope optical fiber 1, and after outgoing radiation of it is carried out and it passes multi/demulitiplexer b3b from the rare-earth-elements dope optical fiber 1, outgoing radiation of it is carried out from signal optical output terminal 4b.

[0014] Drawing 2 is drawing showing the example of 1 configuration of the good light variation turnout 6. For the input edge of the good light variation turnout 6, and 7b, in drawing, the branching outgoing end a of the good light variation turnout 6 and 7c of the branching outgoing end b of the good light variation turnout 6 and 8 are [7a / a reflection factor / permeability adjustable disk, and 9] total reflection

mirrors. It dichotomizes with a reflection factor / permeability adjustable disk 8, and while the excitation light by which incidence was carried out from input edge 7a branched, it is outputted from outgoing end a7b, and after [another] being branched while turned up by the total reflection mirror 9, it is outputted from branching outgoing end b7c. In the front face of a reflection factor / permeability adjustable disk 8, the thin film from which a reflection factor/permeability changes continuously is given to the circumferencial direction, by rotating a reflection factor / permeability adjustable disk 8, a reflection factor/permeability changes and excitation light is outputted to branching outgoing end a7b and branching outgoing end b7c by the ratio of arbitration.

[0015] making high the rate of a branching ratio to branching outgoing end a7b of the good light variation turnout 6 of excitation light, and making low the rate of a branching ratio to branching outgoing end b7c of the good light variation turnout 6 -- the property of the rare-earth-elements dope optical fiber amplifier of front excitation -- near -- becoming -- low -- a noise rare-earth-elements dope optical fiber amplifier is obtained. By making low the rate of a branching ratio to branching outgoing end a7b of the good light variation turnout 6 of excitation light, and making high the rate of a branching ratio to branching outgoing end b7c of the good light variation turnout 6 on the contrary, it becomes close to the property of the rare-earth-elements dope optical fiber amplifier of back excitation, and a high power rare-earth-elements dope optical fiber amplifier is obtained.

[0016] Since a change of the rate of a branching ratio can be made by rotating a reflection factor / permeability adjustable disk 8, it is very easy. For this reason, implementation of the rare-earth-elements dope optical fiber amplifier which has a suitable noise property and a signal optical output property according to an application is easy, and the high rare-earth-elements dope optical fiber amplifier of versatility can be realized. Moreover, since the excitation light source is driven in the state of the fixed load, it becomes neither a heavy load nor low loading.

[0017] As mentioned above, the rare-earth-elements dope optical fiber which doped the rare earth elements which amplify signal light by the exposure of excitation light to the optical fiber in this example, The multi/demulitiplexer a of the excitation light optically combined with the excitation light source which outputs excitation light, and the end of the above-mentioned rare-earth-elements dope optical fiber, and signal light In the rare-earth-elements dope optical fiber amplifier equipped with the multi/demulitiplexer b of the excitation light optically combined with a different edge from the end of the above-mentioned rare-earth-elements dope optical fiber, and signal light From the above-mentioned excitation light source, have the good light variation turnout which dichotomizes the excitation light by which outgoing radiation was carried out into the ratio of arbitration, and one side of branching of the above-mentioned good light variation turnout is optically combined with the above-mentioned multi/demulitiplexer a. The rare-earth-elements dope optical fiber amplifier characterized by combining optically another side of branching of the above-mentioned good light variation turnout with the above-mentioned multi/demulitiplexer b was explained.

[0018] One another example of this invention is explained about drawing below

example 2. Drawing 3 is the block diagram of one another example of this invention. In drawing in 1, a rare-earth-elements dope optical fiber and 2a the excitation light source a and 2b The excitation light source b In 3a, Multi/demulitiplexer a and 3b a signal light input terminal and 4b for Multi/demulitiplexer b and 4a A signal optical output terminal, 5a -- for a good light variation turnout and 7a, the input edge of the good light variation turnout 6 and 7b of the branching outgoing end a of the good light variation turnout 6 and 7c are [the nonreflective termination a of multi/demulitiplexer a3a, and 5b / the nonreflective termination b of multi/demulitiplexer b3b, and 6 / the branching outgoing end b of the good light variation turnout 6 and 10] multiplexing machines.

[0019] Next, actuation is explained. After being multiplexed with the multiplexing vessel 10, incidence of the excitation light by which outgoing radiation was carried out from the excitation light and excitation light source 2b by which outgoing radiation was carried out from excitation light source 2a is carried out to the good light variation turnout 6 from good light variation turnout input edge 7a. Future actuation is the same as actuation of the above-mentioned example 1. Moreover, implementation of the rare-earth-elements dope optical fiber amplifier which has a suitable noise property and a signal optical output property according to an application is easy like the above-mentioned example 1, and since each of excitation light source 2a and excitation light source 2bs is driven in the state of the fixed load, they becomes neither a heavy load nor low loading, but they can realize the high rare-earth-elements dope optical fiber amplifier of versatility.

[0020] In the example 3. above-mentioned example, although the good light variation turnout 6 showed the case where excitation light was branched into the ratio of arbitration by rotating a reflection factor / permeability adjustable disk 8, a case so that a reflection factor/permeability may be made to change by modification of not only when rotation determines a ratio, but an include angle is sufficient as it. Or a case so that a reflection factor/permeability may be changed is sufficient by changing the quality of the material of not only modification [mechanical as mentioned above] but components, or changing electric field and a field by the control circuit.

[0021] In the example 4. above-mentioned example, although the case where it was made to multiplex excitation light and signal light using Multi/demulitiplexers 3a and 3b was shown, multiplexing means other than multi/demulitiplexers, such as an optical coupler and a multiplexing machine, may be used.

[0022] In the example 5. above-mentioned example, although the case of the optical fiber which doped rare earth elements was made into the example and explained, if it is the optical fiber with which other optical fibers also have the property amplified by excitation light, this invention is applicable.

[0023]

[Effect of the Invention] as mentioned above -- according to the optical fiber amplifier concerning this invention -- an application -- responding -- a configuration -- it is not necessary to change -- easy -- low -- a noise optical fiber amplifier or a high power optical fiber amplifier is realizable, and it becomes

neither a heavy load nor low loading, but the excitation light source is effective in the ability to contribute to a magnification operation efficiently while it can secure dependability.

[Translation done.]
* NOTICES *
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damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the rare-earth-elements dope optical fiber amplifier by one example of this invention.
[Drawing 2] It is drawing showing the example of 1 configuration of the good light variation turnout used for one example of this invention.
[Drawing 3] It is the block diagram of the rare-earth-elements dope optical fiber amplifier by one another example of this invention.
[Drawing 4] It is the block diagram of the conventional rare-earth-elements dope optical fiber amplifier.
[Description of Notations]
1 Rare-Earth-Elements Dope Optical Fiber Excitation Light Source
2a Excitation light source a
2b Excitation light source b
3a Multi/demulitiplexer a
3b Multi/demulitiplexer b
4a Signal light input terminal
4b Signal optical output terminal
5a Nonreflective termination a of Multi/demulitiplexer a
5b Nonreflective termination b of Multi/demulitiplexer b
6 Good Light Variation Turnout
7a Good light variation turnout input edge
7b The branching outgoing end a of a good light variation turnout
7c The branching outgoing end b of a good light variation turnout
8 Reflection Factor / Permeability Adjustable Disk
9 Total Reflection Mirror
10 Multiplexing Machine

[Translation done.]
* NOTICES *

DRAWINGS

[Drawing 1]

[Drawing 2]

[Drawing 4]

[Drawing 3]

[Translation done.]